

PATENT  
Atty. Docket No. SNS-006  
(7268/10)

THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANTS: Shih et al.  
PATENT NUMBER: 6,421,048 GROUP NUMBER: 2763  
SERIAL NO.: 09/340,875  
FILING DATE: June 28, 1999 EXAMINER: Phu K. Nguyen  
TITLE: Systems and Methods for Interacting With Virtual Objects in a  
Haptic Virtual reality Environment

**REQUEST FOR CERTIFICATE OF CORRECTION UNDER 35 U.S.C. § 254**

U.S. Patent and Trademark Office  
Office of Publications  
Query and Correspondence Branch  
Crystal Plaza 2, Room-6C30  
Washington, D.C. 20231  
Attention: Certificate of Correction Branch

Dear Sir:

The Assignee of record in the above-referenced patent, SensAble Technologies, Inc., by virtue of an assignment recorded February 7, 2000 at Reel 10574, Frame 0331, hereby requests that a Certificate of Correction be issued for U.S. Patent No. 6,421,048 under 35 U.S.C. § 254 and 37 C.F.R. § 1.322.

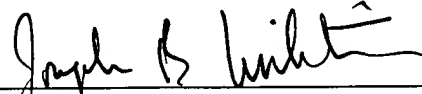
Please insert the language that appears in the attached Certificate of Correction. The language was presented in claim 38, line 2, reading "points" instead of "point." A copy of the stamped return receipt postcard, a copy of the claim as filed, and claim as issued are enclosed hereto, with the correct language in claim 38 having been highlighted. The Assignee believes that no fee is due because the error was made by the U.S. Patent and Trademark Office.

Request for Certificate of Correction  
U.S. Patent No. 6,421,048 B1  
Serial No. 09/340,875  
Filing Date June 28, 1999

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If there are any questions regarding this matter, the U.S. Patent and Trademark Office is kindly requested to contact the undersigned at the telephone number identified below.

Respectfully submitted,



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**COPY**

The "RECEIVED" stamp of the Patent Office imprinted hereon  
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Utilit.; Patent Application Transmittal (1 page); Patent Application Data Entry Form (2 pgs.); Patent Application including: Specification (56 pgs.); Claims (10 pgs.); Abstract (1 page); Formal Drawings (25 sheets); and postcard all by Express Mail Label No. EL280661986US

Name of Applicant:

Shih et al.

Intf. or Serial Number

Not yet assigned

Atty:

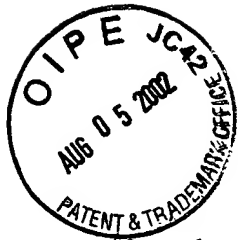
CWStamos/JSSouthworth

Date:

June 28, 1999

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COPY

19 the virtual representation with the virtual surface is detected at the first proposed  
20 location.

38 1 32. The method of claim 31<sup>37</sup> wherein the step of evaluating at least one of the  
2 plurality of discrete points comprises determining an interference point from the  
3 plurality of discrete points, the interference point interfering with the virtual  
4 surface at the first proposed location, and wherein the step of proposing the  
5 second proposed location comprises calculating the second proposed location  
6 based on local geometry information of the virtual surface near the interference  
7 point.

39 1 33. The method of claim 32<sup>38</sup> further comprising a step of determining a vector  
2 formed by projecting the haptic interface location onto a plane passing through a  
3 current location of the virtual representation, the plane being tangent to the virtual  
4 surface near the interference point for the first proposed position. and wherein the  
5 step of proposing the second proposed location comprises proposing the second  
6 proposed location in the direction of the vector.

40 1 34. The method of claim 31<sup>37</sup> further comprising the steps of  
43 2 evaluating at least one of the discrete set of points to detect interference of  
3 the virtual representation with the virtual surface for the second proposed location  
4 of the virtual representation;  
5 moving the virtual representation to the second proposed location if no  
6 interference of the virtual representation with the virtual surface is detected; and  
7 proposing a third location of the virtual representation if interference of  
8 the virtual representation with the virtual surface is detected at the second  
9 proposed location.

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23. The method of claim 19 further comprising a step of determining a force feedback vector and a step of sending the force feedback vector to the user through a haptic interface.

24. The method of claim 23 wherein the step of determining the force feedback vector comprises determining the force feedback vector derived from a difference in position of the haptic interface location and the virtual representation location.

25. The method of claim 24 wherein the step of determining the force feedback vector comprises determining the force feedback vector derived from a difference in velocity of the haptic interface location and the virtual representation location.

26. The method of claim 19 wherein the step of determining the virtual representation comprises determining a virtual tool.

27. The method of claim 26 wherein the step of determining the virtual tool comprises arranging the plurality of discrete points of the virtual tool to approximate a sphere.

28. The method of claim 19 wherein the step of generating a virtual surface comprises generating a virtual object from a closed surface.

29. The method of claim 28 further comprises steps of reading the virtual object from a file, modifying the virtual object in shape, and saving the virtual object to the file.

30. The method of claim 19 wherein the step of moving the virtual representation comprises moving the virtual representation iteratively.

31. The method of claim 19 wherein the step of limiting movement is achieved by determining a constraint plane based on the geometry of the virtual surface.

32. The method of claim 19 wherein the step of limiting movement is achieved by determining a constraint edge based on the geometry of the virtual surface.

33. The method of claim 19 wherein the step of determining the haptic interface location comprises determining a position and an orientation of a haptic interface.

34. The method of claim 33 further comprising a step of determining a force feedback vector; a step of sending the force feedback to the user through the haptic interface, wherein the haptic interface is adapted for measuring six degrees of freedom.

35. The method of claim 34 further comprising the step of applying the force feedback vector through the haptic interface device with less than six degrees of freedom of force feedback.

36. The method of claim 34 wherein the step of determining the force feedback comprises a step of determining a force in at least one of three principal directions and a torque in at least one of three principal rotations.

37. A method for interfacing with a virtual surface in a haptic virtual environment, comprising:

generating a virtual surface in the haptic virtual environment;

sensing a location of a user in real space;

determining a virtual representation of the user in real space, the virtual representation comprising a plurality of discrete points;

determining a haptic interface location in the haptic virtual environment in response to the location of the user in real space;

determining a virtual representation location in the haptic virtual environment;

proposing to move the virtual representation to a first proposed location in the direction of the haptic interface location;

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evaluating at least one of the plurality of discrete points of the virtual representation to detect interference of the virtual representation with the virtual surface for the first proposed location of the virtual representation;

moving the virtual representation to the first proposed location if no interference of the virtual representation with the virtual surface is detected; and

proposing a second location of the virtual representation if interference of the virtual representation with the virtual surface is detected at the first proposed location.

38. The method of claim 37 wherein the step of evaluating at least one of the plurality of discrete point comprises determining an interference point from the plurality of discrete points, the interference point interfering with the virtual surface at the first proposed location, and wherein the step of proposing the second proposed location comprises calculating the second proposed location based on local geometry information of the virtual surface near the interference point.

39. The method of claim 38 further comprising a step of determining a vector formed by projecting the haptic interface location onto a plane passing through a current location of the virtual representation, the plane being tangent to the virtual surface near the interference point for the first proposed position and wherein the step of proposing the second proposed location comprises proposing the second proposed location in the direction of the vector.

40. The method of claim 39 further comprising the steps of

evaluating at least one of the discrete set of points to check for interference of the virtual representation with the virtual surface for the second proposed location of the virtual representation;

moving the virtual representation to the second proposed location if no interference of the virtual representation with the virtual surface is detected; and

proposing a third location of the virtual representation if interference of the virtual representation with the virtual surface is detected at the second proposed location.

41. The method of claim 40 further comprising a step of determining a line formed by the intersection of two planes, the two planes derived from local geometry information in a region near the first proposed location and the second proposed location, and wherein the step of proposing the third proposed location comprises determining the third proposed location in the direction of the line.

42. The method of claim 40 further comprising a step of determining a resultant vector from the cross product of two vectors derived from local geometry information in a region near the first proposed location and second proposed location, and wherein the step of proposing the third proposed location comprises determining the third proposed location in the direction of the proposed resultant vector.

43. The method of claim 37 further comprising the steps of

evaluating at least one of the discrete set of points to detect interference of the virtual representation with the virtual surface for the second proposed location of the virtual representation;

moving the virtual representation to the second proposed location if no interference of the virtual representation with the virtual surface is detected; and

points =

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 6,421,048 B1  
DATED : July 16, 2002  
INVENTOR(S) : Shih et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

*Not* ~~Column 32, Line 13.~~  
~~Column 32, Line 13.~~ replace "point" with --points--.

MAILING ADDRESS OF SENDER: Patent Administrator      PATENT NO.: 6,241,048 B1  
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At claim 38, line 2, replace "point" with --points--.

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